DEPARTMENT OF ELECTRONICS AND ELECTRICAL COMMUNICATIONS ENGINEERING (EEC)
FACULTY OF ENGINEERING
TANTA UNIVERSITY

EEC3213: Optical Communications
Power Launching and Coupling

Problem Set

Mahmoud Selim

March 10, 2016

P1: A Laser diode has lateral ($\Phi = 0°$) and transverse ($\Phi = 90°$) half-power beam widths of $2\theta = 60°$ and $30°$, respectively.
What are the transverse and lateral power distribution coefficients for this device ?

P2: An LED with a circular emitting area of radius $20\mu m$ has a lambertian emission pattern with a 100-W/$(cm^2.sr)$ axial radiance at a 100-mA drive current.
(a) How much optical power can be coupled into a step-index fiber having a 100-μm core diameter and $NA = 0.22$?
(b) How much optical power can be coupled from this source into a $50 - \mu$m core diameter graded index fiber having $\alpha = 2$, $n_1 = 1.48$, and $\Delta = 0.01$?

P3: A GaAs optical source that has a refractive index of 3.6 is closely coupled to a step-index fiber which has a core refractive index of 1.465. If the source size is smaller than the fiber core, and the small gap between the source and the fiber is filled with a gel that has a refractive index of 1.305, what is the power loss in dB from the source into the fiber ?

P4: Plot the maximum coupling efficiencies as a function of the source radius $r_(s)$, for the following fibers:
(a) Core radius of 25μm and $NA = 0.16$,
(b) Core radius of 50μm and $NA = 0.20$.
Let r_s ranges from 0 to 50μm with step 10μm.
In what regions can a lens improve the coupling efficiency?

P5: What is the coupling efficiency between two step-index fibers if they are axially misaligned by $d = 0.1a$?

P6: Using the following two equations, prove that:
(a) $M = k^2 \int_0^a NA^2(r) r dr = k^2 NA^2(0) \int_0^a \left[1 - \left(\frac{r}{a}\right)^{\alpha}\right] r dr$
(b) $\eta_F = \frac{M_{common}}{M_E}$

- The coupling power loss in dB for two fibers with unequal core radii is
  $$L_f = \begin{cases} -10 log(\frac{a_R}{a_E})^2 & for\ a_R < a_E \\ 0 & for\ a_R \geq a_E \end{cases}$$
- The coupling power loss in dB for two fibers with unequal numerical apertures is
  $$L_f = \begin{cases} -10 log\left[\frac{NA_R(0)}{NA_E(0)}\right]^2 & for\ NA_R(0) < NA_E(0) \\ 0 & for\ NA_R(0) \geq NA_E(0) \end{cases}$$
- The coupling power loss in dB for two fibers with different core index profile is
  $$L_f = \begin{cases} -10 log\frac{\alpha_R(\alpha_E+2)}{\alpha_E(\alpha_R+2)} & for\ \alpha_R < \alpha_E \\ 0 & for\ \alpha_R \geq \alpha_E \end{cases}$$